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Chapter 20

Notes on the high elevation mammal fauna of the Kaijende Highlands, Enga Province, Papua New Guinea

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SUMMARY

Renewed mammal survey efforts in high elevation forests and subalpine habitats in the Kaijende Highlands, undertaken in July 2008, recorded 17 species of mammals (9 marsupials, 7 rodents, 1 bat) primarily on the basis of small mammal trapping, mistnetting, and examination of bones and teeth recovered from caves. At least two of these species, a bandicoot (*Microperoryctes*) and a pygmy possum (*Cercartetus*), are unnamed species, although these do not occur exclusively in the Kaijende Highlands, being known also from other mountain areas of New Guinea. Two species, the insectivorous bat *Nyctophilus microdon* and the moss mouse *Pseudohydromys fuscus*, represent new records for Enga Province, and the giant rat *Mallomys rothschildi* is newly recorded from the Kaijende Highlands. The capture of two individuals of *Nyctophilus microdon* in forest at 3,315 m extends the recorded elevational distribution of this bat by more than 1,000 m. This survey provided sufficient new information to re-examine the IUCN conservation status classification of two poorly known mammal species (*Nyctophilus microdon* and *Rattus giluwensis*, both previously listed as “Data Deficient”, now recommended as species to be classified as “Least Concern”), an important result for conservation prioritization and planning. The presence of the amphibious rat *Crossomys moncktoni*, previously recorded from the Kaijende Highlands only on the basis of informant interviews, is confirmed by a mandible from a cave deposit, probably accumulated via predation by the Sooty Owl, *Tyto tenebricosa*. Close inspection of mammal remains from a single cave accumulation revealed that at least 12 species of mammals, mostly nocturnal taxa weighing less than 500 grams, make up the diet of owls in the area, with the Pygmy ringtail *Pseudochirulus mayeri* being the most important prey species. This survey brings the total number of native mammal species known to occur in the Kaijende Highlands above 2,000 meters to 38, and in Enga Province to at least 41.

INTRODUCTION

Helgen (2007c) provided the first review of the mammal fauna of Papua New Guinea’s Enga Province, based primarily on mammals recently collected in the Kaijende Highlands, the expansive montane region surrounding the town of Porgera. Enga Province has received less attention in surveys of mammalian biodiversity than any other province in Papua New Guinea, which is especially notable in light of the fact that the mammal faunas of neighboring provinces (particularly Southern Highlands, West Sepik, Western Highlands, and Madang Provinces) have been the targets of considerable field collecting and systematic study (e.g. Brass 1964, Laurie 1952, Dwyer 1990, Flannery and Seri 1990, Flannery 1995, Leary and Seri 1997, Bonaccorso 1998, Helgen 2007a, 2007c). Here we report the results of renewed survey efforts aimed at documenting local mammal diversity at localities near Porgera in the Kaijende Highlands of Enga Province during July 2008.

MATERIALS AND METHODS

Data collection and sampling methods

As noted in a previous review of Kaijende Highlands mammals (Helgen 2007c), because the majority of Melanesian mammals can only be reliably identified by comparison with series of museum specimens (Flannery 1995, Bonaccorso 1998, Helgen 2007a), scientific efforts to document mammalian biodiversity in New Guinea require the collection and long-term preservation of voucher specimens. We obtained voucher specimens on the 2008 RAP survey by excavating osteological material from a cave, scavenging osteological material of naturally-deceased animals, and by a combination of live-trapping (Sherman traps) and lethal trapping (snap traps) for small ground mammals, and mist netting of bats.

Protocols for capture and handling of mammals followed standard guidelines established by the American Society of Mammalogists for animal care and use (Gannon et al. 2007). For each specimen prepared as a museum voucher, standard external measurements were taken with a ruler (total length, tail length, hind foot length with and without the claws, ear length, and in the case of bats, forearm length) and Pesola scales (body mass). The sex and maturity of each specimen were assessed in the field, and microhabitat and other ecological data were noted for each specimen. Vouchers were prepared as fluid preparations (fixation in 10% formalin, then transferred to 70% ethanol for long-term storage) or as study skins and/or skeletons. For each freshly collected specimen, liver, kidney, and/or muscle tissue was preserved in 95% ethanol for subsequent genetic analyses. Some small mammals were photographed in life in semi-natural settings. Specimens from the Kaijende Highlands RAP survey are deposited in the Division of Mammals at the National Museum of Natural History (USNM), part of the Smithsonian Institution in Washington, D.C., along with their associated temporal, geographic, ecological, and mensural data, and genetic samples.

Common names generally follow Flannery (1995) or (for bats) Bonaccorso (1998), but in a few cases (among rodents) where taxonomic changes have necessitated a change in vernacular usage, common names follow Musser and Carleton (2005).

Conservation classifications provided for each species (Critically Endangered, Endangered, Least Concern, etc.) derive from the current rankings on the IUCN Red List (www.iucnredlist.org), most recently revised as part of the Global Mammal Assessment, an effort by mammalogists worldwide to summarize the current state of knowledge individually relevant to the conservation of every living mammal species (Schipper et al. 2008).

Study sites

The mammal survey focused on two sites in an area accessible by road from the town of Porgera and the Porgera Joint Venture (PJV) mining operation. These were Kai-ingri, a

high elevation forest site surrounded by sub-alpine grassland (July 6 to 10, 2008), and a cave situated in subalpine grassland adjacent to the Porgera Reservoir at Waile Creek (July 28–29, 2008).

Kai-ingri

A camp and study site was established at Kai-ingri (05°34.442'S, 143°02.896'E), situated at 3,315 m in upper montane forest surrounded by subalpine grassland (described in more detail by Takeuchi, Chapter 9, this volume).

We established a trap-line in the forest and grassland for 'removal trapping' of small mammals. Forty medium-sized Sherman live traps and 20 'museum special' snap traps were set each night, for five nights, on the forest floor and in vegetation and low trees up to 3 meters above the ground. These traplines resulted in 34 catches (= 11% trap success) representing three species (*Rattus niobe*, *Paramelomys rubex*, and *Cercartetus* sp.; see species accounts below). Mist-nets set by day for catching birds were monitored at night for opportunistic bat-catching. Five nights of netting yielded only two individuals of one bat species, *Nyctophilus microdon*. A harp trap was set along a trail in upper montane forest for 3 nights, but no bats were captured.

Mammals were also documented at Kai-ingri by day hunting and scavenging. Day hunting involved searching for roosting and sleeping sites of arboreal mammals during the day. One marsupial, the ringtail possum *Pseudochirops cupreus*, which sleeps by day either in tree hollows or in burrows, was obtained in this manner by local hunters. Another marsupial, the diurnal dasyurid *Neophascogale lorentzii* was observed and photographed by Stephen Richards. Skull remains of one species, the cuscus *Phalanger sericeus*, were scavenged from the forest-grassland edge at Kai-ingri.

Cave at Waile Creek

In late July 2008 we collected and studied bones from a large cave overlooking the lake and reservoir at Waile Creek (ca. 05°33'56"S, 143°03'35"E, 3,010 m). The cave floor and entrance were saturated with osteological remains of small mammals, suggesting accumulation by an owl. Given the altitude of this collection site (ca. 3,000 m), the only likely candidate for producing these deposits is the Sooty Owl, *Tyto tenebricosa* (see Beehler et al. 1986). Several hundred jaws and teeth were collected from the cave floor and entrance. At least twelve mammal species were identifiable among these remains (Table 20.1; a handful of mostly edentulous mandibles have not yet been definitively identified and are not further reported on here, but seem most likely to additionally represent small rodents in the genera *Pogonomys* and *Abeomelomys*). Ken Aplin revisited this cave site in September 2009 and collected additional samples that have yet to be analysed and will be reported elsewhere. The Minimum Number of Individuals (MNI) in Table 20.1 is calculated based on the greatest number of either left mandibles or right mandibles (whichever is the largest count) for each taxon in the assemblage.

Table 20.1. Mammal species and their abundance in an assemblage of bones in the cave above the Porgera Reservoir at Waile Creek. MNI = minimum number of individuals (see materials and methods). Most of these bones were probably accumulated via predation by the Sooty Owl, *Tyto tenebricosa*. Identifications and abundances are based on our study of maxillary and mandibular fragments. A small number of edentulous jaws represent additional taxa, probably *Pogonomys* and *Abeomelomys*, but require more definitive comparison and are not tallied here. One additional species, *Uromys anak*, was reported from owl pellets at Waile Creek, based on a single juvenile individual (Helgen 2007c).

Species	MNI	Activity	Principal Habitat	Mass (grams)
<i>Pseudochirulus mayeri</i>	82	nocturnal	forest	100-200
<i>Microperoryctes</i> sp.	22	nocturnal	grassland/forest	400-700
<i>Rattus giluwensis</i>	16	nocturnal	grassland	50-100
<i>Cercartetus</i> sp.	16	nocturnal	grassland/forest	15-25
<i>Coccyzus shawmayeri</i>	12	nocturnal	grassland/forest	22-45
<i>Rattus niobe</i>	11	nocturnal	grassland/forest	40-50
<i>Petaurus brevipes</i>	2	nocturnal	forest	50-120
<i>Murexia hageni</i>	1	nocturnal	forest	20-40
<i>Dasyurus albopunctatus</i>	1	variable	forest	500-1000
<i>Crossomys moncktoni</i>	1	nocturnal	streamside	150-250
<i>Mallomys rothschildi</i>	1	nocturnal	grassland/forest	900-1600
<i>Pseudohydromys fuscus</i>	1	nocturnal	forest	14-26

RESULTS

During this survey we documented the occurrence of 17 mammal species including 9 marsupials, 7 rodents, and 1 bat (Table 20.2). Combined with a previous review of the mammals of the region (Helgen 2007c), these results increase the total number of native marsupials, rodents, and bats recorded in the Kaijende Highlands to 38 (Table 20.2) and in Enga Province to 41. The murine rodents *Mallomys rothschildi* and *Pseudohydromys fuscus* and the vespertilionid bat *Nyctophilus microdon* are reported from the Kaijende Highlands for the first time.

ANNOTATED SPECIES LIST

Order Dasyuromorphia, Family Dasyuridae (Carnivorous Marsupials)

Dasyurus albopunctatus Schlegel, 1880 (New Guinea Quoll)
IUCN Red List Status: Near Threatened (owing to declines in some regions; Woolley et al. 2008a).

Previously documented elevational range: Sea level to 4,000 m (Helgen 2007b).

Status in Enga Province: Previously reported (see Helgen 2007c).

This medium-sized dasyurid (500-1000 g) is a scansorial carnivore that inhabits forested areas across most of New Guinea. One mandible of *D. albopunctatus* (with dentition mature and intact) was recovered from the cave at Waile Creek.

Murexia hageni (Laurie, 1952) (Small Eastern Mountain Dasyure)
IUCN Red List Status: Least Concern (as *Murexia habbema*).

Previously documented elevational range: 1,600 to 3,400 m (Helgen 2007c).

Status in Enga Province: Previously reported (see Woolley 1989, Woolley et al. 1991, Helgen 2007c).

This small dasyurid (*ca.* 30 grams) is a nocturnal, largely terrestrial animalivore that inhabits high montane forests in Papua New Guinea. We recovered a mandible and maxillary fragment attributable to this species from the cave at Waile Creek. As noted previously (Helgen 2007c), in the past *M. hageni* has usually been considered a synonym of *M. habbema* (Tate and Archbold, 1941) (Woolley 1989, Woolley et al. 1991, Flannery 1995, Van Dyck 2002). However, the taxonomy and distribution of *Murexia* (including the nominal genera *Micromurexia*, *Murexechinus*, and *Paramurexia* of Van Dyck (2002); cf. Krajewski et al. (2000)) are currently under review by Helgen and Darrin Lunde (*in litt.*), who recognize *M. hageni* as a distinct species endemic to Papua New Guinea's central and eastern highlands regions (Helgen 2007a, 2007b).

Neophascogale lorentzii (Jentink, 1911) (Speckled Dasyure)
IUCN Red List Status: Least Concern (Woolley et al. 2008b).

Previously documented elevational range: 1,200 to 3,900 m (Helgen 2007b).

Status in Enga Province: Previously reported (see Helgen 2007c).

Neophascogale lorentzii, a medium-sized, diurnal predator of small vertebrates and insects, is known from montane

forests throughout much of New Guinea's central cordillera. This species was observed and photographed at Kai-ingri by Stephen Richards. Little is known of its natural history (Flannery 1995, Woolley et al. 2008b).

Order Peramelemorphia, Family Peramelidae (Bandicoots)

Microperoryctes unnamed species (Subalpine Striped Bandicoot)

IUCN Red List Status: An undescribed taxon, not yet listed.

Previously documented elevational range: 3,000 to 3,600 m (Helgen *in prep.*).

Status in Enga Province: Previously reported (see Helgen 2007c).

As noted by Helgen (2007a, 2007c), examination of the large collections of *Microperoryctes* in world museums indicates that an undescribed species of striped bandicoot occurs on the highest peaks of central and eastern Papua New Guinea, with known localities primarily associated with tussock grasslands above the treeline (> 3,000 m elevation). Mandibles and maxilla recovered from the cave at Waile Creek are tentatively referred to this unnamed species on the basis of mandibular and molar morphology. Museum specimens referred to this taxon, which will be described in a pending taxonomic revision of the genus (Helgen *in prep.*), also derive from other high-elevation peaks in Papua New Guinea, including Mt. Giluwe, Mt. Wilhelm, and Mt. Albert Edward. A similar congener, *M. ornata*, also occurs in the Kaijende Highlands, but at lower elevations (Helgen and Flannery 2004, Helgen 2007c).

Table 20.2. The mammals of the Kaijende Highlands, Enga Province, as recorded by this survey and by previous survey efforts. 'X' designates that the record is vouchered by a specimen. '(X)' designates that the record is based on a convincing sighting, photograph, or informant account (Helgen 2007c). Previous survey efforts were summarized by Helgen (2007c).

Species	Surveys up to 2005	This survey July 2008
Monotremata (Tachyglossidae)		
<i>Zaglossus bartoni</i>	(X)	
Dasyuromorphia (Dasyuridae)		
<i>Dasyurus albopunctatus</i>	X	X
<i>Murexia hageni</i>	X	X
<i>Murexia naso</i>	X	
<i>Neophascogale lorentzii</i>	(X)	(X)
Peramelemorphia (Peramelidae)		
<i>Microperoryctes ornata</i>	X	
<i>Microperoryctes</i> sp.	X	X
<i>Peroryctes raffrayana</i>	X	
Diprotodontia (Macropodidae)		
<i>Dendrolagus dorianus</i>	X	
<i>Dorcopsulus vanheurni</i>	X	
<i>Dorcopsulus</i> sp.	X	
<i>Thylogale calabyi</i>	X	
Diprotodontia (Phalangeridae)		
<i>Phalanger carmelitae</i>	X	
<i>Phalanger gymnotis</i>	X	
<i>Phalanger sericeus</i>	X	X
Diprotodontia (Pseudocheiridae)		
<i>Pseudochirulus forbesi</i>	X	
<i>Pseudochirulus mayeri</i>	X	X
<i>Pseudochirops cupreus</i>	X	X
Diprotodontia (Burramyidae)		
<i>Cercartetus</i> sp.	X	X

Species	Surveys up to 2005	This survey July 2008
Diprotodontia (Petauridae)		
<i>Dactylonax palpator</i>	X	
<i>Petaurus breviceps</i>	X	X
Rodentia (Muridae)		
<i>Coccymys shawmayeri</i>	X	X
<i>Crossomys moncktoni</i>	(X)	X
<i>Mallomys rothschildi</i>		X
<i>Mallomys istapantap</i>	X	
<i>Mammelomys lanosus</i>	X	
<i>Mirzamys norahae</i>	X	
<i>Parahydromys asper</i>	(X)	
<i>Paramelomys rubex</i>	X	X
<i>Protochromys fellowsi</i>	X	
<i>Pseudohydromys ellermani</i>	X	
<i>Pseudohydromys fuscus</i>		X
<i>Rattus giluensis</i>	X	X
<i>Rattus niobe</i>	X	X
<i>Uromys anak</i>	X	
Chiroptera (Pteropodidae)		
<i>Syconycteris</i> cf. <i>australis</i>	X	
Chiroptera (Vespertilionidae)		
<i>Nyctophilus microdon</i>		X
Chiroptera (Molossidae)		
<i>Tadarida kuboriensis</i>	(X)	

Order Diprotodontia, Family Phalangeridae (Cuscuses)*Phalanger sericeus* Thomas, 1907 (Silky Cuscus)**IUCN Red List Status: Least Concern**

Previously documented elevational range: 1,500 to 3,900 m (Flannery 1995, Helgen 2007b).

Status in Enga Province: Previously reported (see Helgen 2007c).

The Silky Cuscus is a medium-sized phalanger (mass *ca.* 2-2.5 kg) that occurs in montane forest at high elevations along New Guinea's central cordillera. Skull fragments of this species were picked up in grassland fringing the forest at Kai-ingri. This species is hunted and eaten by people in the Kaijende Highlands (Helgen 2007c).

Order Diprotodontia, Family Burramyidae (Pygmy Possums)*Cercartetus* unnamed sp. (New Guinea Mountain Pygmy Possum)
IUCN Red List Status: An undescribed taxon, not yet listed.

Previously documented elevational range: approximately 1,200 to 3,700 m (Helgen *in prep.*).

Status in Enga Province: Previously reported from the Kaijende Highlands as *Cercartetus caudatus* (see Helgen 2007c).

Possums of the genus *Cercartetus* are tiny animals (mass *ca.* 20 grams) that occur in New Guinea across the length of the central cordillera and in the outlying mountains of the Vogelkop and Huon Peninsulas. They are scansorial insectivores that live in montane forests and grasslands (Helgen 2007b). Though only a single *Cercartetus* species is recognized in New Guinea under current taxonomy (Flannery 1995, Helgen 2007b), recent detailed studies of New Guinean *Cercartetus* samples in world museums by Helgen demonstrate that at least two biological species occur in New Guinea, overlapping broadly in distribution though largely occurring in different habitats and at different elevations, and distinguishable by color, facial markings, body size, external proportions, and craniodental features. One of these taxa is associated with upper montane forests and subalpine grasslands in the central cordillera, and has not yet received a scientific name. Mandibles and maxilla representing this species were recovered from the cave at Waile Creek, and one specimen (USNM 585489) was trapped in forest at Kai-ingri at night on a tree branch situated 1.5 meters above the forest floor. This species will be described in a taxonomic revision of New Guinea *Cercartetus* in preparation by Helgen.

Order Diprotodontia, Family Petauridae (Striped Possums and Gliders)*Petaurus breviceps* Waterhouse, 1838 (Sugar Glider)**IUCN Red List Status: Least Concern.**

Previously documented elevational range: Sea level to 3,000 m (Flannery 1995).

Status in Enga Province: Previously reported (see Helgen 2007c).

Several mandibles of a small *Petaurus* were recovered from the cave at Waile Creek. Though only a single small-bodied species of *Petaurus* (*P. breviceps*) is recognized in New Guinea under current taxonomy (Flannery 1995), studies of morphology and genetics (Colgan and Flannery 1992, Flannery 1994, Helgen 2007b, Malekian et al. 2010) indicate that several different species will eventually need to be recognized pending a detailed taxonomic revision of Melanesian members of the genus.

Order Diprotodontia, Family Pseudocheiridae (Ringtail Possums)*Pseudocheirus cupreus* (Thomas, 1897) (Coppery Ringtail)**IUCN Red List Status: Least Concern.**

Previously documented elevational range: 1,350 to 4,000 m (Helgen 2007b).

Status in Enga Province: Previously reported (see Helgen 2007c).

This large ringtail (1.5-2.5 kg) is a common inhabitant of montane forests throughout New Guinea's central cordillera. One specimen of this species, an adult female weighing 1.85 kg (USNM 586239), was captured while sleeping by day in a tree hollow at Kai-ingri. Its stomach was engorged with leaf matter. This species is commonly hunted and eaten by people living in the Kaijende Highlands (Helgen 2007c).

Pseudocheirus mayeri (Rothschild and Dollman, 1932) (Pygmy Ringtail)**IUCN Red List Status: Least Concern.**

Previously documented elevational range: 1,200 to 4,200 m (Helgen 2007b).

Status in Enga Province: Previously reported (see Helgen 2007c).

This small ringtail (100-200 grams) is a common inhabitant of montane forests from 1,200 to at least 4,200 m elevation throughout New Guinea's central cordillera. This was the species most abundantly represented by skulls and teeth in the cave at Waile Creek, presumably indicating that it is common in high elevation landscapes of the Kaijende Highlands, and that it is a favoured prey species of the Sooty Owl (see Table 20.1).

Order Rodentia, Family Muridae (Rats and Mice)*Coccymys shawmayeri* (Hinton, 1943) (Shaw-Mayer's Mouse)**IUCN Red List Status: Least Concern (as *Coccymys ruemmleri*).**

Previously documented elevational range: 1,600 to 3,660 m (Musser and Lunde 2009).

Status in Enga Province: Previously reported from the Kaijende Highlands as *Coccymys ruemmleri* (Menzies 1990, Helgen 2007c) and recently re-allocated taxonomically to *C. shawmayeri* (Musser and Lunde 2009: 13).

This small scansorial murine (mass *ca.* 30 grams) is an inhabitant of montane forests and alpine grasslands throughout the middle portion of the central cordillera (Musser and Lunde 2009). We recovered many mandibles and maxillary fragments attributable to this species from the cave at Waile Creek. Referral to *C. shawmayeri* (rather than *C. ruemmleri*, which is known only from farther to the west, in the Snow and Star Mountains) is based on these specimens' relatively short molar rows (maxillary M1-3 4.10–4.41 mm, *n* = 4, mean = 4.24 mm) and short bony palates (4.30–4.84 mm, *n* = 6, mean = 4.44 mm) (cf. Musser and Lunde 2009). *Coccyzomys* is among the rodents most abundantly represented in the cave at Waile Creek, presumably indicating it is commonly preyed upon in the Kaijende Highlands by the Sooty Owl (see Table 20.1).

Crossomys moncktoni Thomas, 1907 (Earless Water-Rat)

IUCN Red List Status: Least Concern.

Previously documented elevational range: 1,200 to 3,600 m (Helgen 2007b).

Status in Enga Province: Previously reported only on the basis of informant interviews, but not backed by voucher specimen until now (see Helgen 2007c).

Crossomys moncktoni is the most aquatic of all murine rodents and is classified in a monotypic genus (Thomas 1907; Helgen 2005). A medium-sized species (*ca.* 200 grams), it is endemic to New Guinea's central cordillera where it occurs in association with streams in montane forests from at least as far east as Papua New Guinea's Central Province in south-eastern New Guinea to at least as far west as the Swart Valley (Flannery 1995, Musser and Carleton 2005, Helgen 2007b). Helgen (2007c) suggested that *Crossomys* was present in the Kaijende Highlands based on clear knowledge of the animal expressed by a local hunter, who described it well and referred to it by the Ipili language name *Ambulimawa*. A single specimen (a mandible with teeth) recovered from the cave at Waile Creek during the 2008 RAP expedition represents *Crossomys moncktoni*, confirming its occurrence in the area (Table 20.1).

Mallomys rothschildi Thomas, 1898 (Rothschild's Woolly-Rat)

IUCN Red List Status: Least Concern.

Previously documented elevational range: 1,450 to 3,700 m (Helgen 2007a).

Status in Enga Province: Possibly previously reported (Helgen 2007c; see below).

Three species of *Mallomys* - large, scansorial "woolly-rats" - co-occur in the central cordillera in Papua New Guinea: *M. aroensis*, *M. rothschildi*, and *M. istapantap* (Flannery et al. 1989, Helgen 2007a). Paired mandibular rami recovered just outside the cave at Waile Creek (length of lower first molar 6.7 mm, width 4.8 mm; length of mandibular molar row 16.6 mm) represent an adult individual of *M. rothschildi* (Table 20.1), the smallest and most arboreal member of the genus. Both *M. rothschildi* and *M. istapantap* are now known from the Kaijende Highlands (Helgen 2007c).

Mallomys rothschildi was previously known from Enga Province by a specimen at the PNGNM marked "Lumus, Enga Province" but this may in fact refer to the locality of Lumis (= Lumusa), situated in Western Highlands Province (Helgen 2007c). Species of *Mallomys* are hunted and eaten by people in the Kaijende Highlands (Helgen 2007c).

Paramelomys rubex (Thomas, 1922) (Mountain Paramelomys)

IUCN Red List Status: Least Concern.

Previously documented elevational range: 900 to 3,000 m (Flannery 1995, Helgen 2007b).

Status in Enga Province: Previously reported (see Helgen 2007c).

Paramelomys rubex is a small, largely terrestrial, omnivorous rat that occurs in montane areas throughout New Guinea (Flannery 1995). It is often the most common terrestrial mosaic-tailed rat in New Guinean montane forests. However, current taxonomic interpretations of *P. rubex* are likely to incorporate multiple distinct, currently undiagnosed species, such that a detailed taxonomic revision of the group remains an important priority in New Guinea mammalogy (Helgen 2007b). We trapped a series of *P. rubex* at Kai-ingri, where it was the most commonly trapped rodent after *Rattus niobe*. It was trapped at night in the forest under logs, in hollows underneath tree roots, amongst a treefall, and under a pile of grass at the forest edge. Surprisingly, no *P. rubex* jaws or teeth were discovered in the cave at Waile Creek, apparently indicating that *P. rubex* is not an important element in the diet of Sooty owls in the Kaijende Highlands (Table 20.1). Earlier studies of owl pellets in the Kaijende Highlands, from rock outcroppings rather than caves, also did not record remains of *P. rubex* (Helgen 2007c).

Pseudohydromys fuscus (Laurie, 1952) (Short-tailed Moss-Mouse)

IUCN Red List Status: Least Concern.

Previously documented elevational range: 1,600 to 3,660 m (Helgen and Helgen 2009).

Status in Enga Province: New record, first reported on the basis of this survey by Helgen and Helgen (2009).

Pseudohydromys fuscus is a very small, insectivorous, terrestrial moss-mouse that inhabits high elevation forests in the central portion of the central cordillera, from Porgera and the Tari Gap in the west to Mt. Kaindi in the east (Helgen and Helgen 2009). It co-occurs in the Kaijende Highlands with at least two other 'moss-mouse' species, *Pseudohydromys ellermani* and *Mirzamys norahae* (the latter, collected by Pat Woolley and known only from the Kaijende Highlands, was discussed as an unnamed genus and species by Helgen [2007c] and recently named and described by Helgen and Helgen [2009]). *Pseudohydromys fuscus* is reported here from the Kaijende Highlands on the basis of a single jaw, with teeth, recovered from just outside the cave at Waile Creek (Table 20.1).

Rattus giluwensis Hill, 1960 (Giluwe Rat)

IUCN Red List: Data Deficient: “Listed as Data Deficient in view of the absence of recent information on its extent of occurrence, threats, and conservation status. This species is found only on three or four mountain tops, but may occur more extensively on Mt. Giluwe. Increased fire frequency (already happening) due to global warming may be a future threat, but the impacts of fires on small rodents needs to be studied” (Leary et al. 2008).

Previously documented elevational range: 2,195 to 3,660 m (Taylor et al. 1982).

Status in Enga Province: Previously reported (see Helgen 2007c).

Prior to its discovery in subalpine grasslands in the Kaijende Highlands (Helgen 2007c), this distinctive rat was known only from the vicinity of Mt. Giluwe in Southern Highlands Province, Papua New Guinea (Taylor et al. 1982, Flannery 1995). Previous trapping in the Kaijende Highlands recovered it only from open grasslands, not from forest or forest margin habitats (Helgen 2007c), though it has been trapped in high-elevation forest habitats on Mt. Giluwe (Taylor et al. 1982). It was the rodent represented most abundantly by bones and teeth in the cave at Waile Creek, presumably indicating that it is a common prey species of the Sooty Owl (see Table 20.1).

This species was classified in the most recent IUCN Red List assessment for mammals as “Data Deficient”, owing to a lack of information on the species’ distribution, threats, and information on natural history. Work in the Kaijende Highlands, both from trapping in subalpine grasslands (Helgen 2007c), and from study of bones in the cave at Waile Creek (this survey), has shown that this rat is more widely distributed than previously realized (Taylor et al. 1982, Flannery 1995, Musser and Carleton 2005) and that it is common in appropriate habitat (mainly subalpine grassland). Given its reasonably wide extent of elevational occurrence, abundance, distribution centered on sparsely inhabited wilderness areas, and the fact that it does not seem to be under active threat from human activities, we recommend “Least Concern” as a better IUCN Red List classification.

Rattus niobe Thomas, 1906 (Moss-Forest Rat)

IUCN Red List: Least Concern.

Previously documented elevational range: 1,200 to 4,000 m (Taylor et al. 1982 [corrected]). Taylor et al. (1982) reported the lower elevational bound of occurrence for *R. niobe* as 2,500 feet (as “762 m”), which was a lapsus for 2,500 meters (see Musser and Lunde 2009: 14). This species usually occurs above 1,500 m and Taylor et al. (1982) documented no other localities below 1,200 m.

Status in Enga Province: Previously reported (see Helgen 2007c).

Current taxonomic interpretations of *Rattus niobe* (Musser and Carleton 2005, Helgen 2007b) restrict its occurrence to the eastern half of the New Guinean central cordillera. Even with the taxonomic exclusion of a number of former

synonyms (Musser and Carleton 2005, Helgen 2007b), the taxonomy of *Rattus niobe* is highly problematic and probably incorporates multiple species that may be widely sympatric in the mountains of Papua New Guinea. As with series collected during the 2005 Kaijende RAP (Helgen 2007c), we here tentatively identify the most common murine collected at Kai-ingri as *Rattus niobe*. It is a small (adult specimens from Kai-ingri weighed 39-52 grams), largely terrestrial rat that was trapped in the forest and in adjacent grassland at night under logs, brush, treefalls, dense vegetation, piles of grass at the base of trees, and on tree branches up to one meter above the ground. This was also one of the rats most abundantly represented by jaws and teeth in the cave at Waile Creek, indicating it is probably an important prey species of the Sooty Owl in the Kaijende Highlands (see Table 20.1). Detailed study of the morphology and genetics of trapped specimens will be needed to evaluate the tentative hypothesis that all specimens from the 2008 RAP survey (and 2005 RAP survey; Helgen 2007c) represent a single biological species, and that the appropriate name for this taxon is *R. niobe* (cf. Musser and Carleton 2005).

Order Chiroptera, Family Vespertilionidae (Evening Bats)*Nyctophilus microdon* Laurie and Hill, 1954 (Small-toothed Long-Eared Bat)

Current IUCN Red List Status: Data Deficient: “This species is listed as Data Deficient in view of the absence of information about its distribution, threats, and conservation status. The limited known range (ca. 2,000 km²) of this species means that research into these topics (particularly to determine whether or not the species is more widespread) should be a priority” (Bonaccorso et al. 2008).

Previously documented elevational range: 1,900-2,200 m (Flannery 1995, Bonaccorso 1998)

Status in Enga Province: Newly recorded.

Nyctophilus microdon is a central highlands endemic vespertilionid bat recognizable by its small size (forearm 35-41 mm, mass 4.0-8.5 g), very large ears (20-24 mm), and very short canines (height \leq 2.0 mm) (measurements compiled from most known specimens). The capture of two individuals of *Nyctophilus microdon* in forest at Kai-ingri (3,315 m), a male and female mist-netted together, extends the recorded elevational distribution of this bat (reported as 1,900-2,200 m by Flannery 1995, Bonaccorso 1998, and Bonaccorso et al. 2008) by more than 1,000 meters. The identification of these specimens as *microdon* was confirmed by Harry Parnaby, global authority on *Nyctophilus* taxonomy (e.g., Parnaby 1987, 1988, 2002, 2009).

Because so little is known about *N. microdon*, it is worth reviewing the limited information previously published about its distribution. Laurie and Hill (1954) first described the species based on 7 specimens at the Natural History Museum (London) (BMNH 53.212-53.218), all collected by F. Shaw Mayer in 1951 from “Welya, west of Hagen Range” at 7000 feet (i.e., approximately 2,100 m, at the

locality now associated with the name Weylya or Kumdi *vide* Bonaccorso [1998: 442], 05°42'S, 144°09'E, Western Highlands Province, Papua New Guinea).

Brass (1964) reported a second locality for *microdon* from Mt. Wilhelm (05°48'S, 145°02'E) on the border of Chimbu and Eastern Highlands provinces, the basis of this record being 6 specimens at the American Museum of Natural History (AMNH 191402-191404, 192256-192258) collected during the Sixth Archbold Expedition to New Guinea in 1959 and sourced at sites designated by the names “east slopes” (Pengagl), Gumuna, Gembol, and Waimambuno (the last three localities probably associable with the currently used place names Gumine, Gembogl, and Waimumbug [cf. Bonaccorso 1998]). Brass (1964) noted that mammal specimens were purchased from local collectors (no doubt over a wide range of elevations), and that a specimen of *microdon* sourced while at Pengagl may have been brought from as low as 6,500 feet (= 1,980 m).

Most recently, Flannery (1995) and Bonaccorso (1998) mentioned specimens of *N. microdon* from two additional localities. Two specimens at the Australian Museum in Sydney (AM M12634-12635), a male and female mist-netted together (22 July 1978), were collected at Atea Gana Anda (05°35'S, 142°32'E), a cave on the Muller Plateau in Southern Highlands Province, situated at approximately 2,100 m. Four specimens in the Australian National Wildlife Collection in Canberra (CSIRO M8522-8525) were collected at “Uinba, Wahgi Valley, Kubor Range” (06°00'S, 144°37'E) at 6,200 feet (= 1,890 m) on 21 June 1963, apparently captured while roosting amongst *Pandanus* leaves.

The only published record of occurrence for *N. microdon* in western New Guinea is from 2,600 m in the Arfak Mountains of western New Guinea (Craven 1988, Petocz 1989), but this was apparently based on a specimen deposited at the Natural History Museum (London) later identified as the more widely distributed Melanesian species *N. microtis* by John Edward Hill (Flannery 1995: 459).

Previously published and currently accepted records of occurrence for *N. microdon* are thus based on 4 localities or general areas (Weylya, Mt. Wilhelm, Uinba, and Atea Gana Anda) spanning Eastern Highlands, Chimbu, Western Highlands, and Southern Highlands provinces of Papua New Guinea, and together documenting a very limited elevational range of occurrence from 1,890 to 2,100 m.

However, in addition to the new Enga Province record reported here, we also note that the National Museum of Sweden in Stockholm holds two specimens referable to *N. microdon*, a male and female collected on the same date (25 August 1951, labeled in the collection “no. 3” and “no. 4”) by Gyldenstolpe at Nondugl (05°54'S, 144°44'E) in Western Highlands Province, apparently at approximately 1,600 m (Gyldenstolpe 1955). Thus, as reported here the distribution of *N. microdon* spans much of the central highlands of New Guinea and extends from 1,600 to 3,315 m in elevational occurrence. Our review of specimen records from the Sixth Archbold Expedition further reveals that

N. microdon was one of the most commonly collected bats on the 1959 expedition to Mt. Wilhelm. All specimens collected to date appear to result from the opportunistic discovery of roosting animals, or from mist-netting. More regular use of harp traps and echolocatory equipment in New Guinea bat surveys (see Armstrong and Aplin, Chapter 19, this volume) are likely to confirm that this bat is more common in the New Guinea highlands than previously realized, and might also confirm a wider distribution across other areas of the highlands both to the east and west, where it should be sought in future New Guinea biodiversity survey efforts. Given its wider extent of elevational occurrence than previously realized, and its inferred highlands distribution which incorporates sparsely inhabited wilderness areas, this species is likely more common than previously realized, and does not seem to be under active threat from human activities. We are now able to recommend “Least Concern” as a better IUCN Red List classification than “Data Deficient.”

Little is yet known of the natural history of *N. microdon* apart from the notes on distribution presented here, and that it roosts in trees or caves (Bonaccorso 1998). In this light, we note that of the few occasions when *N. microdon* has been encountered by mammalogists, three of these have been captures of an adult male and female at the same time (at Nondugl, Atea Gana Anda, and Kai-ingri), perhaps indicating that this bat associates and forages in male-female pairs.

CONSERVATION RECOMMENDATIONS

The principal contributions of the 2005 and 2008 Kaijende Highlands RAP surveys to mammalian conservation biology have been to 1) establish the importance of the Kaijende Highlands as a significant wilderness area where many of New Guinea's larger and most endangered montane mammals (such as *Zaglossus bartoni*, *Dendrolagus dorianus/notatus*, *Dorcopsulus* spp., and *Thylogale calabyi*) still occur (Helgen 2007c), and 2) to establish some baseline information about the distribution and basic biology of poorly known small mammal species of Papua New Guinea's highest-elevation habitats, including *Rattus giluwensis*, *Nyctophilus microdon*, and undescribed species of *Microperoryctes* and *Cercartetus*. Together these surveys have added substantially to knowledge of the mammals of Enga Province, about which little had been previously reported.

As before (Helgen 2007c), we reiterate that few firm steps can be taken with regard to conservation, management, and/or protection of mammals in the vicinity of Porgera without a more intricate understanding of their distribution, abundance, and threats that they face. With few exceptions, little is known of most mammal species in the region, such that broader survey efforts and more focused research on individual focal species are needed before specific recommendations for conservation and management be made. Here we revise and reiterate previous summary recommendations

relevant to mammal conservation in the Kaijende Highlands (Helgen 2007c):

Basic biodiversity surveys, such as the survey work discussed herein, should continue, incorporating more sites and additional habitats, especially in midmontane areas (1,500–2,500 m). Mammalogical research in Enga Province to date has probably documented less than 50% of the actual Kaijende Highlands mammal fauna (Helgen 2007c). Further surveys will undoubtedly record additional species in the area, potentially including species of conservation concern and focus such as the critically endangered Bulmer's Fruit-Bat (*Aproteles bulmerae*).

Targeted ecological studies are still needed to assess in greater detail the distribution, abundance, and threats faced by certain larger "focal species" in the region, such as echidnas (*Zaglossus*), tree kangaroos (*Dendrolagus*), and wallabies (*Dorcopsulus* and *Thylogale*) (Helgen 2007c).

Focused research on the natural history of the most poorly known and geographically restricted species that occur around Porgera, including the rodents *Mirzamys norahae* (the only species currently considered endemic to the Kaijende Highlands) and *Rattus giluensis*, the vespertilionid bat *Nyctophilus microdon*, the pademelon (wallaby) *Thylogale calabyi*, and the undescribed bandicoot (*Microperoryctes* sp.) and pygmy possum (*Cercartetus* sp.), among others, would fill important gaps in natural history knowledge and constitute globally important contributions to mammalogy. Many of these species occur only in high-altitude habitats such as tree fern savanna, tussock grassland, and adjacent upper montane (elfin) forests.

Because of the unique fauna they support, the Kaijende Highlands' tree fern savanna, tussock grassland, and adjacent upper montane forests are habitats of profound conservation value. The area of extent and environmental quality of these open alpine habitats and the status of the mammals they support are prime subjects for long-term monitoring studies in response to global warming (Helgen 2007c).

Providing local communities with information about the basic natural history of local mammals could be one of the most important steps that might be taken toward the long-term conservation of larger, rarer, or geographically restricted mammals in the region. This could be achieved by dissemination of posters, fact sheets, and/or small field guides that illustrate local wildlife, discuss its significance to local communities, and emphasize such concepts as rarity and sustainable hunting. The impact and educational value of such postings and publications could be vastly increased by including relevant text in Tok Pisin, English, and Ipiili or other appropriate local languages. This is one positive step for environmental management and community outreach that is not incumbent on additional, extensive background research (Helgen 2007c).

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